Sensor-based variable-rate N: Long-term performance in corn and cotton

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Objective & Relevance:

The objective of this project is to evaluate long-term performance of sensor-based variable N rate recommendations for corn and cotton. Sensor-based N will be compared with typical producer N management and with other N rate decision systems.

This project is relevant to Missouri agriculture because nitrogen fertilizer management has profound effects on profitability and on the environment. Previous research has shown a wide range of optimal N rates for both corn and cotton in Missouri. Crop sensors are a promising technology for diagnosing and applying the correct N rate in a single pass through the field. Sensor measurements can predict the optimal N rate for both corn and cotton in a one-year experiment. We want to understand more about their performance over the long term.

This project addresses the topic "Long term study on Variable Rate Technology on corn and cotton" identified in the Request for Proposals.

Procedures:

- Three small-plot experiments will be conducted, a corn experiment at Bradford Farm near Columbia and a corn and a cotton experiment at the Delta Center near Portageville.
  - The Columbia corn experiment has been conducted from 2007 to 2014. This proposal will leverage what we've already accomplished and allow us to create a truly long-term evaluation of sensor-based N for corn.
    - To date, sensor-based variable-rate N is tied with one other treatment as the most profitable N management system.
  - The Portageville cotton experiment has been conducted for 3 years (2010, 2011, 2013). Although it was not conducted in 2014, the exact plot locations are known so that the same treatments can continue on the same plots.
    - Historical effects of N management systems on soil N dynamics will be captured.
    - This proposal will leverage what we've already accomplished.
    - To date, sensor-based variable-rate N is tied in the group of most profitable N management systems.
  - The corn experiment at Portageville will be new. Soils and cropping systems in the Delta are different enough that results from the Columbia experiment do not necessarily apply. Having a corn experiment in Portageville will help to establish whether sensor-based variable-rate N management can succeed there.
- This project will continue to build on our previous research to establish equations to calculate optimal N fertilizer rate from sensor measurements in both corn and cotton.
- Treatments for the corn experiment will include:
  1. Reflectance sensor, sidedress only. Nitrogen rate will be calculated using reflectance

sensor measurements taken at growth stage V7 (knee high) and an equation from our previous research on these sensors.
2) Reflectance sensor, split application. Sidedress rate will again be calculated from sensor measurements, but 50 lb N/acre will be applied pre-plant.
3) Standard N rate of 140 lb N/acre. This is the rate that produced the Maximum Return To Nitrogen (the recommendation approach recently adopted by Iowa, Illinois, Minnesota, and Wisconsin) in 30 on-farm experiments all over Missouri.
4) Preplant soil nitrate test. A nitrogen rate credit (as described in Missouri guidesheet G9177) based on a preplant soil nitrate test will be subtracted from the 140 lb base rate.
5) Sidedress soil nitrate test. Nitrogen rate will be calculated using the Iowa State University interpretations.
6) Chlorophyll meter. Nitrogen rate will be calculated using chlorophyll meter measurements taken at growth stage V7 (knee high) and an equation from our previous research.
7) High rate: 180 lb N/acre
8) Low rate: 100 lb N/acre
9) Check treatment. No N fertilizer applied.

- The existing corn experiment includes all treatments listed above except for treatment 2. We have observed substantial early season N stress in the current sensor treatment (zero N preplant), and are concerned that this may have limited yields in good years. We will add a small adjacent experiment including sensor-determined N rates with and without preplant N (treatments 1 and 2) along with the standard rate (140) and the high rate (180). This will allow us to comparatively evaluate sensors + preplant N without disturbing the existing experiment.
- Treatments for the cotton experiment will include:

1) Reflectance sensor, topdress only. Nitrogen rate will be calculated using reflectance sensor measurements taken at the mid-square growth stage and an equation from our previous research on these sensors.
2) Reflectance sensor, split application. Topdress rate will again be calculated from sensor measurements, but 30 lb N/acre will be applied pre-plant.
3) Standard N management of 50 lb N/acre preplant and 50 lb N/acre topdressed at early square stage.
4) Soil test system. A preplant soil nitrate test will be used to calculate an N credit which will be subtracted from the standard preplant application.
5) Petiole nitrate system. A preplant application of 50 lb N/acre will be followed by petiole nitrate testing at early square, mid square, and early flower stages. An additional 50 lb N/acre application will be triggered by deficient petiole nitrate levels.
6) High rate: 50 lb N/acre preplant + 80 lb N/acre early square.
7) Low rate: 20 lb N/acre preplant + 50 lb N/acre early square.
8) Check treatment. No N fertilizer applied.

- Both experiments will use a randomized complete-block design with six replications.
- Sensor N rates will be based on sensor measurements in the individual plot. All other N rate systems will be used to produce a single N rate which will be applied to all plots of that treatment.

Current status and importance of sensor-based variable-rate nitrogen:

- Sensors to diagnose and control N fertilizer rate are maturing as a commercial product.

- There are three main brands available: Greenseeker (Trimble), OptRx (Ag Leader), and TopCon.
  - -The acquisition of these sensors by bigger ag companies (Trimble, Ag Leader) in the past few years has moved them forward in both perception and adoption.
- There are producers and/or retailers in Missouri running all three brands, but adoption is not yet widespread.
- People still need objective information to help them decide whether to invest in canopy sensors as a nitrogen management tool.

- Several years of widespread N loss in corn across the midwest, with superior yields from in-season N applications, has increased interest in supplying N in-season.
  - Minimal use of sidedress N for corn outside of the southeastern U.S. has been a limiting factor for sensor-based N management.
- Sensors fit current N management practices for cotton fairly well, since most producers use in-season applications of N.
- Our research shows wide variability within fields, between fields, and between years in how much N is needed.
  - Sensors offer the potential to diagnose these differences and apply N rates that are more profitable.

Timetable:

March 2015	Prepare experimental areas.
April 2015	Take preplant soil samples. Apply preplant N treatments. Plant corn.
May 2015	Plant cotton.
June-July 2015	Take sidedress soil samples and petiole samples. Take N sensor and chlorophyll meter measurements. Apply sidedress & topdress treatments.
September 2015	Harvest corn, defoliate cotton.
October 2015	Harvest cotton
Nov-Dec 2015	Analyze data.
December 2015	Progress report.
March ‘16-Dec ‘16	Repeat March ‘15-Dec ‘15 tasks March ‘17-Dec ‘17 Repeat March ‘15-Dec ‘15 tasks December 2017 Final report.
Jan-Feb 2018	Develop educational programs, present results at Extension meetings.

Strategy for application/transfer of knowledge:

- Written and oral (presentation) educational materials will be developed to promote understanding and application of results.
- Written materials will include newsletter and farm press articles. I am used as a source by many Ag Journalists.
- Presentations will be used in Extension meetings, sent to regional Extension Agronomists for their use, and shared with anyone who requests them.
- Results will be posted on the University of Missouri Nutrient Management website

Budget:

Category	Amount budgeted in:		
	2015	2016	2017
Columbia experiment labor and benefits	$8000	$8000	$8000
Delta experiments labor and benefits	14000	14000	14000
labor for data analysis and website	3000	3000	4000
soil and petiole sample analyses	500	500	500
field supplies and fuel	500	500	500
TOTAL	$26,000	$26,000	$27,000

3-year total budget **$79,000**